

287009

JPRS 81734

9 September 1982

# West Europe Report

SCIENCE AND TECHNOLOGY

No. 119

19981203 096

**DISTRIBUTION STATEMENT A**

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# WEST EUROPE REPORT SCIENCE AND TECHNOLOGY

No. 119

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## ENERGY

### PHOTOVOLTAIC RESEARCH: PROGRESS IN THIN FILM TECHNOLOGY

Paris L'USINE NOUVELLE in French 10 June 82 pp 174-175

[Article by Claude Amalric "Photovoltaic Research: Progress in Thin Film Technology"]

[Text] There were few earth-shaking papers this year at the fourth colloquium on photovoltaic solar energy, but many improved processes, particularly in ingots, strips and thin film. The equipment and poster exhibit confirmed that. A noticeable absence: that of the Americans.

More than ever Georges Kamarinos went to the annual colloquium on photovoltaic technology to see colleagues. For this Grenoble scientist, "the era of big ideas has come to an end. What we have here is only technology," he says regretfully, without disputing its utility. It was from an appropriate technology that the Mitsubishi team (the first ones to do it) drew amorphous silicon from the laboratory. In the exhibit, in connection with the colloquium reserved for "posters," shock results had the visitors dreaming. While the main problem of thin film cells is to reach a surface in excess of  $1 \text{ cm}^2$  without loss of efficiency--and without a short circuit--the Japanese indicate a 5.4 percent efficiency obtained with a  $10 \times 10 \text{ cm}$  amorphous silicon cell. A panel which was removed quickly even described a cell of this type with dimensions of  $20 \times 20 \text{ cm}$ . In order to understand the importance of these figures, one must go on to the next poster where Siemens announces 5 percent, but over approximately  $6.5 \text{ cm}^2$ !

In the search for the largest deposit of amorphous silicon (a-Sil) without a short circuit, it is Cambridge University that holds the record, with a  $60 \text{ cm}$  disk that is homogeneous to within 5 percent.

The other recognized thin film approach is cadmium sulfide on copper ( $\text{CdS}/\text{Cu}_2\text{S}$ ). There are no triumphs here: the migration of the copper in the CdS makes these cells unstable in the long run, to the point that the beautiful Solar Energy System factory built to produce such cells for the American residential sector has ceased its activity. In addition, the manufacturing efficiency is low: fewer than 50 percent of the cells made are good. A bleak picture. However, that fact did not deter Saint-Gobain Recherches which, since the first of the year, has been in the process of acquiring the technology perfected at Montpellier University by Michel Savelli for the thin film deposit of CdS cells. "It

is a natural step on the part of glass makers who master practically all of the techniques required: the deposit of large surface thin films on glass (tinted windows), encapsulation (double panes)... and the price of glass which only they are able to evaluate." Even before CdS becomes a reliable method, it is possible to estimate the cost of such cells to within 20 percent. The estimation made shows the solar watt at less than one dollar in 1986...if the method succeeds in solving its problems. It should be noted that Saint-Gobain is now under the French government, as is Photon Power (by CFP-Total [French Petroleum Company]), the other "pole" of CdS. Under such conditions, wouldn't it be preferable to advocate on behalf of the taxpayers the pooling of the know-how of these two laboratories, in competition until now, in order to give CdS a chance to succeed before the investors give up?

All the more because solutions seem to exist for the instability and the difficulties of manufacturing CdS cells. The proof of it is the Nukem company, in Hanau (West Germany), which had an exhibit at Stresa. According to Hans Bogensberger, physicist and director of the programs of the firm, CdS cells perfected by Stuttgart University showed no measurable deterioration over three years of exposure, with a conversion efficiency of between 4.5 and 7 percent. So that a 150 kW/year pilot unit is being constructed. "We are thinking about starting production at the end of this year, with the goal of going below DM 20 per watt at first. But after one or two years, we hope to make 600 kW to 1MW per year. Then, the price per watt would fall to DM 3 to 5..." 10 francs a watt? That would be ten to fifteen times less than what can be bought in France at the present time.

Jean-Pierre Dumas, director of the materials division of the CGE [General Electricity Company] laboratories, is hardly impressed by that. "Today the hierarchy of methods is: ingots, strips, thin films. But of course an unforeseen event can change everything. But that is not yet the case." The ingot is silicon cooled slowly in a square crucible. Its advantages over "drawn" silicon are: less loss of material and an easy realization of square cells reducing the surface of a panel for a given power. At the exhibit, at the stand of Photowatt, a subsidiary of CGE, a square ingot 20 cm on a side was ensconced on a pedestal. "Industrialization planned around 1983-1984," commented Jean-Pierre Dumas.

Drawn in a monocrystal or cooled in a polycrystalline ingot, silicon must still be sawed into slices approximately 0.5 mm thick. Since the kerf is as broad as the slice is thick, half of the silicon is thrown out at the end of its preparation where its cost is maximal. In order to avoid the constraint and the loss due to sawing, other methods have been devised. One of the most promising consists of producing silicon in a strip. At the Philips laboratory in France (LEP [Electronics and Applied Physics Laboratory]), a strip of graphite was drawn from a crucible containing molten silicon. Adopted since then by CGE, this technique progressed greatly at the end of 1981. By burning the graphite in oxygen at 1000°C, it was possible to obtain two strips of silicon with a single drawing. In addition, the solar cells are easier to manufacture after that. "Accounting for the work that remains to be done on this product, its industrialization cannot be foreseen prior to 1985," says Jean-Pierre Dumas.

Another pole of French research in photovoltaic technology is being created at Valbonne. A team directed by Claude Verie of the CNRS [National Center for Scientific Research] will study "rainbow" cells, that is, cells sensitive to the entire solar spectrum. In fact it involves several cells grouped together with each one being specialized by its materials and doping materials for a spectral band. A conversion efficiency of 40 percent is possible perhaps about 1986. These monocrystalline cells are for light concentration systems (500 to 1000 suns). The second project for this laboratory is to make cells of tinned amorphous silicon (doped with tin) which could reach 12 percent efficiency over 1 cm<sup>2</sup>. (Until now, three laboratories have reached 8 percent with amorphous silicon: SERI [Solar Energy Research Institute], RCA and Mitsubishi.)

The speeches practically repeated the results shown on the posters. With a large void: this year there were almost no American speakers. One of the principal [speakers] who had been planned apparently was forbidden to make his trip to Stresa. "Now that their budget has been greatly reduced, they are falling back on themselves," observes Georges Kamarinos. "In addition, one notices that they never told us everything. For example, look at the results that they are revealing now on the efficiency obtained with thin film other than CdS or silicon: up to 12 percent in 1977, while everyone was getting a few percent with such films."

For this scientist and his colleagues present at Stresa it is clear that nothing has been said in photovoltaic technology. That will be the case until a method exceeds 10 percent efficiency with a very low manufacturing cost and mass production. Today many believe that the thin films will be the first to reach that point.

9969

CSO: 3102/389

## ENERGY

### LARGE-SCALE DUTCH WIND ENERGY PROJECT RECEIVES FIRST FUNDS

West Berlin DER TAGESSPIEGEL in German 17 Jul 82 p 10

[Article by Marion Kern: "Wind Energy Stored in the Sea"]

[Text] Dutch Minister of Economics Terlouw recently made available about DM 30 million for realizing the first stage of his country's ambitious wind energy program. The traditional land of windmills has begun to massively support a "renaissance" of wind energy in order to possibly cover about 8 percent of its electrical demand with the aid of modern windmills by the year 2000. At the focal point of Dutch considerations is "WESP" the "Wind Energy and Electricity Storage Basin Project." WESP will not only take advantage of the wind abundance along the long Dutch coast but will also use the ocean to mitigate the capricious disadvantage that the wind does not always blow hardest when the demand for electricity is greatest.

About 3 years ago the Dutch scientist L. W. Lievense submitted a report to the Ministry of Research in which he proposed the coupling of wind generators with a pump storage system. In response, the ministry commissioned a study group which concretized the plan in WESP. Operation is synchronized with the daily and weekly curves for electrical demand. The electricity supplied by the wind generators will be used to cover daylight peak demand on week days. At night and on weekends, the wind generated electricity will drive pumps which fill a storage basin with water. If the wind offering is not sufficient for peak demand times, then the electrical deficiency will be met with the aid of water power.

Now, of course, there is no high ground along the wind-rich Dutch coast which can be used for the pump storage system; therefore, Lievense proposed building the storage system in the ocean. For this purpose a large area in the Marker Sea--a portion of the IJssel Sea--will be enclosed with high dikes following conventional concepts. When such a basin is filled, its water surface lies appreciably above that of the surrounding open sea. Turbogenerators are built into the foundation of the dikes, and these are driven by water flowing back to sea level when the gates are opened. When filling the basin, the turbogenerators function as electrical pumps.

The storage basin in the sea thus assumes a buffer function between wind offering and energy demand. If a calm prevails over a long period, then, of



course, nighttime electricity from conventional power plants must be used to refill the basin to its minimum level. This serves to assure peak-demand supply.

The wind generators themselves do not have to be located close to the basin since the electricity they generate can be injected into the normal electrical network from which the necessary electricity for filling the basin is extracted during periods of surplus. The power of each wind generator--plans provide for 1,000 units--will be 3 MW.

The realization proposals provide for the successive construction of 3 stages, each with a capacity of 1,000 MW of wind power and 800 MW of water power. The final capacity of WESP would then be 2,400 MW with an annual energy output of approximately 8,000 GWh. This would correspond to about 8 percent of the projected electrical demand of the Netherlands in the year 2000.

In spite of significantly higher investment costs in comparison to conventional power plants, WESP would be amortized after just 5 years according to project-group calculations. The annual savings in petroleum is placed at 500 to 800 million dollars. The first two stages--per project-group recommendation--should be ready for operation at the earliest possible time between 1990 and 1995.

In the first stage of the wind-energy research program, a 1-MW wind generator will now be built as a prototype. The program also includes studies concerning the effects of wind-energy use on the environment as well as studies relating to economic, planning and administrative aspects. Also to be determined is the performance of a group of modern windmills in combination with the electrical network. And, last but not least, the program is expected to determine the maximum percentage of Dutch electrical energy requirements that can be provided by wind energy.

9160

CSO: 3102/402

## ENERGY

### BRIEFS

COD LIVER OIL FUEL--In the land of cod liver they have found a new use for cod liver oil. An Icelandic experiment using cod liver oil instead of diesel oil in trucks has yielded very good results. The "Lysi HF" company in Reykjavik has been using cod liver oil in two of its trucks since last summer. The experiment has shown that diesel engines burn cod liver oil just as well as diesel oil without any damage. With cod liver oil the engines produce lower exhaust emissions than with diesel oil and, in addition, cod liver oil is about 40 percent cheaper than diesel oil in Iceland. [Text] [Helsinki HUFVUDSTADSBLADET in Swedish 25 Aug 82 p 1]

ONE-MEGAWATT PHOTOVOLTAIC POWER PLANT--The world's biggest power plant for photovoltaic production of 1 megawatt of electrical energy, the "Delphos" project, will be built in Puglia, in the Manfredonia zone. The power plant will be built for the ENEL [National Electric Power Agency] and the ENEA [European Nuclear Energy Agency] by a consortium expressly set up in Genoa for the purpose by AGIP [National Italian Oil Co]-Nucleare and Ansaldo. This was announced by the president of AGIP-Nucleare, Dr Giuseppe Sfligiotti, speaking in the Ligurian capital at the Fifth International Congress on Solar Energy and Other Renewable Sources. The consortium will enable the two companies to manage in a rational and programmed manner the construction of this installation that will be capable of transforming sunlight into electricity sufficient for a community of more than 1,000 persons. The value of the order is more than Lit 25 billion, and it is planned for the power plant to go into service in 1985; but since it is a modular installation, it will be possible for electricity to be produced and put into the distribution grid in the first months of that year. For building this sophisticated installation, AGIP-Nucleare will use the know-how acquired by its controlled company Pragma SpA, which has developed particularly sophisticated technologies, partly through the collaboration it has undertaken with some of the leading producers of photovoltaic materiel, such as the American companies Semix, Intersemix and Solarex. [Text] [Rome RASSEGNA PETROLIFERA in Italian 18 Jun 82 p 556] 11267

CSO: 3102/382

## TRANSPORTATION

### FOKKER'S POSITION IN AVIATION COMMUNITY ANALYZED

Paris AVIATION MAGAZINE INTERNATIONAL in French 15-30 Apr 82 pp 42-43

[Article: "A New Strategy for Fokker"]

[Text] Amsterdam--Although it holds close to half the capital shares of SABCA [Belgian Aeronautical Construction Corporation], Fokker is not playing an active role on the Belgian front. Their ties might perhaps have taken on new dimensions if the MDF-100 150-passenger airliner project had materialized, since SABCA was actively involved with it. Other opportunities to strengthen relations between the two firms will therefore have to be awaited. All of which meanwhile is not altering the very good relations between Belgium and the Netherlands.

There was certainly no basis for thinking that the abandonment of the MDF-100 would be a hard blow to the Dutch builder: Its highly diversified activities, which are well distributed between the civil and military sectors, still enable it to view the medium-term future with undisturbed serenity. With 9,500 employees on its payroll and an annual turnover that has now passed the 1-billion-florin mark, a substantial financial balance that will be confirmed by the figures for its 1981 operations, and a distinctive image that conveys an abundant sense of dynamism, it can afford to take the time needed for reflection and to prepare a new strategy for the future, that is, other choices.

The Hague authorities are clearly continuing to rely upon the Schiphol management teams. This means that the considerable support given to the MDF-100 could, at the right moment, be shifted to another sufficiently promising future project. The question is in what direction it will choose to go, having apparently decided to discard the 150-passenger alternative, at least at the level envisioned with McDonnell-Douglas.

Will we find Fokker taking part in the A-320 program in the event the latter is launched? The hypothesis is not to be ruled out, although it would seem to be just a bit premature. On the other hand, from a theoretical standpoint, it would appear reasonable to state that the Dutch firm would willingly take a 10 to 15 percent share of the new civil program, whose technical and commercial credibility are assured.

This possibility will clearly be considered within the terms of reference of a strategy for the future, on which the company's experts are presently at work. Little can be said in this regard at this point except that we must continue to await patiently the outcome of their studies. But ideas are not lacking, whether it be a choice of following up, in time, on the F-27 (the F-XX concept) or an in-depth study of a niche in the marketplace that has been little talked about for many years, namely, that for a new-generation 100-passenger module.

#### The Virtues of Patience

The ability to be patient is currently Fokker's strongest card. The only thing that is being delayed is expansion (the MDF-100 would not have succeeded another program but would have been added to the gamut of its current activities) and, for the immediate future, Fokker's stability is well assured: By the F-16 from the military standpoint and the F-27 and F-28 from the civil one, to say nothing of Fokker's participation in the Airbus 300 and 310 programs as well as the Short SD-330 and -360 ones.

Because of its larger size than that of the two Belgian aircraft manufacturers, Fokker is not in a position of dependence upon the compensation contracts that are tied to the General Dynamics F-16 multinational program. This program represents hardly more than 20 percent of Fokker's total annual turnover and some 1,200 jobs. The 100th American fighter plane assembled at Schiphol will be delivered during the month of June, a chronological checkpoint confirming that that the original schedule is being met.

Furthermore, continuity is assured. Now awaiting the completion of its commitment to produce 106 planes, announced nearly 7 years ago, is the recent decision of the Dutch Air Force to replace its Northrop NF-5's with the same type of plane. Fokker has moreover committed itself to produce the planes needed to cover attrition, which were not included in the original order, bringing the total up to 111 additional planes (40 of which are already on firm order). To these must now be added the planes to be delivered to Norway.

Every month, two F-16's leave the Schiphol assembly line. Added to these are the fuselages destined in part for the Gosselies and Fort Worth assembly lines and hence being produced at a higher rate of output: The 500th subassembly will be delivered in a few weeks. And lastly, production increases are in prospect, based on F-16 sales to third countries, further brightening the outlook for continuity and stability.

Fokker nevertheless fully intends to maintain its position as a builder of civil aircraft and, what is more, its status as prime contractor. A position that is in no danger whatever of being challenged in the immediate future, since the F-27 and F-28 are pursuing imperturbably their careers, despite the uncertainties of the current situation on the one hand, and despite the assaults of the competition on the other.

Soon, 750 F-27's...

The F-27 "Friendship" is being produced at the average rate of two units per month and the orders now total 739 units for not less than 160 users. Even though the American market is marking time, as compared to projections prior to the debacle that has overtaken many regional airlines, Fokker's prospects of continuity remain intact.

While the Dutch firm declines at this time to reveal publicly its intentions, it appears certain that the F-27 must sooner or later undergo a rejuvenation treatment, particularly by way of a retrofit based on the use of new propellers. Talks are already under way with this in mind, with Pratt and Whitney, General Electric and Rolls-Royce, as well as with Hamilton Standard and Dowty Rotol.

Although the twin-jet F-28 "Fellowship" is having to accept a slower pace (188 units sold to date), it too is holding its head well above water. Its production rate remains limited to one and one-half planes per month, but here again the medium-term outlook is one of optimism. Moreover, additional potential markets have appeared on the scene, in the form, for example, of a project for a "navalized" military variant that may be of interest to the United States Navy.

The tack to be taken by the European competition and the Canadian one, which is visibly showing its long teeth, remains to be seen. The F-27 is confronted, of course, by the de Havilland line and will be confronted also by the Franco-Italian ATR-42, while the F-28 will now be coming up against the British Aerospace 146. At Schiphol--without, for that matter, underestimating the attraction of its programs--no effort is being spared to develop a marketing expertise based on the experience gained over the years throughout the world. But it is nonetheless certain that the battle Fokker finds itself fighting will become much more fierce.

It is with all the more interest, therefore, that the emergence of Fokker from its silence to announce its new strategy is being awaited--a strategy that, in large measure and by way of new objectives, will condition the long-term future of the enterprise. For the moment, however, the prevailing mode at Schiphol is serenity.

9399

CSO: 3102/380

## TRANSPORTATION

### DORNIER'S NEW-GENERATION AIRCRAFT: DORNIER 228-100

#### Project Review

Stuttgart FLUG REVUE in German Aug 82 pp 70, 72

[Text] In its Neuauingen factory, Dornier GmbH of Friedrichshafen is gradually converting to a generation of aircraft with excellent sales prospects. Those selling the newest German commuter and utility aircraft, the Do 228, anticipate a worldwide success.

The FRG is regarded as a country with one of the highest standards of living. In order to be able to remain competitive worldwide in spite of this, high-value products and technologies are needed. This is particularly true in the aerospace industry.

Unlike military purchase programs, which are measured by more munificent standards, civilian programs start from a much more difficult basis. The firm of Dornier GmbH, with about 8,500 employees in factories on the Bodensee and in Munich, is converting to the newly developed Do 228 commuter and utility airplane family, following the reduction in the pace of the Alpha jet manufacturing program.

The only large company in the industry in the FRG with private capital, which earned sales worth DM 1,011 million in the business year 1980, with a surplus of DM 27 million, found itself a long time ago faced with the difficult task of keeping jobs and of maintaining its good earnings.

New market studies provided interesting information about the greater need for commuter and utility airplanes in the future. Utility airplanes like the Do 28 D-2 Skyservant have been built for years in the Neuauingen factory. The fuselage in this airplane proved to be particularly robust.

In 1981 The Do 228-100 Received Type Approval

A research program supported by the Ministry for Research and Technology (BMFT) made it possible to develop a completely new wing using significant manufacturing methods, designed expressly for highly cost-effective production. The experimental version, based on a modified Do 28 D-2, was given the new TNT (New Technology Wing) wing, with two Garrett AiResearch TPE 331-5-252 D turboprop engines. The first

flight took place in the summer of 1979. The results were so astonishing that the company directors immediately decided to develop the models known today by the designations 228-100, with 15 seats, and Do 228-200, with 19 seats.

The Do 228-100 was given type approval in December 1981 by the Federal Aviation Office (LBA). Certification of the 200 version will be completed shortly. Almost 100 aircraft, including 27 definite orders, fill the order books of the south German family company. The first airplanes have already been delivered to customers.

Small regional airlines, which see their principle function in providing connector services to larger airports, have shown the greatest interest in this type of aircraft.

Dornier lists the following typical applications:

- Passenger transport
- Passenger and freight transportation
- Business flights
- Ambulance work
- Photogrammetry
- Geophysical applications
- Industrial connecting flights
- Marine patrols
- Search and rescue service
- Training

The company is benefitting from its experience in previous years. The fuselage is based on that of the Do 28 D-2, with a newly developed three-point nose-wheel landing gear.

There were problems in the design of the landing gear. According to Dornier, five different landing gear manufacturers were unable to develop a special landing gear for the 228 in an extremely short time. Dornier engineers solved the problem themselves.

The wing itself is constructed in a special manufacturing process (see also FLUG REVUE 12/1981). Blocks of aluminum form the basis of this new process. In the production shops in Neuauingen, as though controlled by a ghostly hand, the longitudinally and transversely ribbed panels are formed on NC-controlled milling machines and, following thorough checks and finishing operations, are assembled into complete wing boxes. This modern manufacturing method reduces total production costs by 30 percent.

Riveted joints, which are highly time-consuming, are dispensed with, and the upper wing surface is more homogenous and closer to a true profile in the area of the main box, which, besides the many other advantages of the newly designed wing, results in a 30-percent saving in fuel, increased range, improved climbing performance and higher speed.

Both versions have the same engines as the TNT experimental aircraft. A four-bladed Hartzell propeller was chosen for the Garrett turbine from eight different propeller types.

With its modular principle, Dornier has created an entire family of airplanes, which will guarantee full employment of existing manufacturing capacity for years to come. Further system-oriented developments will permit the development of new types in this category, which can be tailored to suit the market, at low additional cost. The biggest handicap of the present family of airplanes is the fact that the fuselage does not have a pressurized cabin.

Comparable models, principally the newly developed commuter airplanes such as the British Aerospace Jetstream 31 and the Fairchild-Swearingen Metro III, have pressurized fuselages allowing higher operating altitudes.

Worldwide interest in the two versions, Do 228-100 and Do 228-200, proves that a German company can be competitive through superior technologies and technical know-how, in spite of clearcut competition.

#### Pilot Report

Stuttgart FLUG REVUE in German Aug 82 pp 72,75

[Article by Robert Rahn: "A Great Deal of Built-In Safety"]

[Text] The airplane is the first preproduction machine, serial number 7001, which was delivered to a Norwegian airline. The design received its certification in December 1981 for visual and instrumented flights in daylight and at night. Although complete de-icing equipment is installed, flights under known icing conditions are not permitted at the present time, because tests under icing conditions have still to be carried out.

Entry for the crew and passengers is through the left half of a double-door measuring 1.28 by 1.34 ms. The cabin is equipped with two rows of generously proportioned comfortable seats. The center aisle is 31 cms wide. Headroom dimensions are not given. In the rear part of the cabin and in the capacious nose section there are two large baggage areas with a substantial payload capacity. The many possibilities for loading require conscientious checking of weight and center of gravity.

#### A Spacious Cockpit

Access to the pilots' seats is somewhat restricted and requires a certain amount of dexterity, since it is necessary to climb over the rear part of the center console. The available space in the cockpit is good. The pilots' seats deserve great praise, their range of adjustability satisfies every wish.

The basic instrumentation, with radio and navigating equipment, is up to the customary standard for today. One must single out the way that all malfunctions have been grouped together in a single main warning cluster in the center of the instrument panel, with the upper row of panels containing the most important warnings shown in red, the remaining panels shown in yellow. The red warnings are also linked to a penetrating 1,000-Hz warning signal. The aircraft has a fire warning system for the engine bay, with two large warning indicators. An extinguishing system is offered only as an option.



The landing gear lever was positioned approximately over the right knee of the pilot, who sits on the left, where it was easy to operate. The hydraulic system has been kept simple and robust. A pump driven by an electric motor is the power source for the landing gear, brakes and nose-wheel steering. For emergencies there is a hand pump in the cockpit, with which the landing gear can be extended. In this event brakes and steering are no longer available. However, by reversing the thrust and modulating the power to the engines, the aircraft can still be braked and steered. The time to extend and retract the landing gear in normal operation is relatively long, 18 seconds for each. Emergency extension requires about 280 strokes of the pump and requires 8 long minutes.

#### Turbine and Propeller Form One Unit

The left half of the center of the instrument panel is taken up by the engine instrumentation. The instruments are circular, arranged vertically. Among them are the so-called "Beta" lights to indicate operation using thrust reversal and the engine limiter switches, which prevent the maximum permissible exhaust temperatures and torque levels from being exceeded--all in all a sensible arrangement.

In the Garrett engines that are used the turbine and the propeller are solidly coupled through gears. At maximum turbine rpm, the propeller reaches a speed of only 1,591 rpm, which results in a relatively low external noise level.

The power plant is equipped with a "Negative Torque and Sensing System," which means that in the event of engine failure the propeller blades are automatically kept in the area of least resistance. This substantially reduces dynamic force during the failure and makes the pilot's job of maintaining control much easier, particularly in the vertical axis.

Engine control is achieved through two levers for each, located on the central console, the throttle lever with provision for thrust reversal and the rpm lever with a setting for propeller feathering and provision for engine shutdown. The right half of the console offers sufficient space for additional equipment, for example, Omega and R-NAV [Random Navigation].

The aircraft can be trimmed in all axes. The electric indicators are located in front of the throttle levers. Unfortunately the controls are not arranged in a unified fashion. Stabilizer trim is operated electrically through a double safety switch on the control column horn, aileron trim is also operated electrically through another rocker switch on the console and the rudder is operated mechanically through a crank in the cockpit ceiling. A better layout for these control elements is being considered at the present time.

Starting the engines takes place automatically and can be carried out with the help of the on-board batteries. Visibility during taxiing is very good. The nose wheel is controlled through the rudder pedals, with the normal range of movement being  $\pm 8^\circ$ . Through a microswitch on the control column horn the range can be expanded to  $\pm 45^\circ$ .

For takeoff it is necessary to preset the elevator trim as a function of the center of gravity and aileron setting, in order to provide a properly adjusted progression of manual effort while turning. Takeoffs are possible with flap settings of  $0^\circ$ ,  $5^\circ$  or  $20^\circ$ . Maintaining direction presents no problems, even in a strong crosswind, due to the steering and the good adhesion of the nose wheels. In a steep climb immediately afterwards, retracting the landing gear does not cause any change in momentum, but the flaps do create a strong, unpleasant change, which has to be compensated for by extensive changes in trim.

Depending on its weight, the airplane can reach rates of climb from 2,000 to 3,800 ft/min. Testing its flying characteristics revealed no other objections through the entire range. The rudders are well balanced, manual effort is relatively high, as befits its intended role as a transport aircraft.

Loss of lift is indicated in all configurations by medium shaking and the nose dropping. Rudder and ailerons always remain effective in the natural direction. There is not sufficient warning from natural aerodynamic buffeting so there is a device to give optical and acoustic warning 10 to 15 knots before loss of lift occurs. Stalling in single-engined flight, in accordance with FAR [Federal Aviation Regulations] 23, with 75-percent power in the remaining engine, revealed similarly good characteristics, without any tendency to unusual, uncontrollable attitudes.

Testing for the slowest speed while retaining controllability in single-engined flight showed a figure of  $V_{mc} = 80$  KIAS [Knots Indicated Air Speed] under actual boundary conditions. This is good confirmation of the manual figure of  $V_{mc} = 81$  KIAS. The high level of performance achieved by the wing design is particularly obvious in the single-engined performance levels. The rates of climb in single-engined flight at medium weights at sea level are 700 to 800 ft/min.

An examination of the manual conducted during the test revealed both qualitative, that is, confirmation of the speed of the best angle of climb and rates of climb ( $V_x$ ,  $V_y$ ), and quantitative good confirmation of the figures in the manual. The design is easily able to meet the supplementary requirements of FAR 23 covering engine failure during takeoff, even with the landing gear extended and the critical engine cut, since it can reach rates of climb of about 250 ft/min at maximum take-off weight.

This means a high level of safety in the takeoff phase in particular, such as exists in large aircraft certified according to FAR 25.

#### Easy Approach With The Do 228-100

Normal cruising speeds are in the range between 170 and 220 KTAS [Knots True Air Speed], where the higher speeds very quickly border on the operating limit of  $V_{mo} = 200$  KIAS, because of the operating altitudes imposed by the lack of a pressurized cabin. A limit about 20 to 30 knots higher would do greater justice to the performance potential of the airplane. Approach and landing are completely problem-free. With centers of gravity located in the middle, the nose wheel drops noticeably toward the ground after the main landing gear has touched down, making the design

extremely insensitive to crosswinds when combined with the steering. The noise level in the cockpit and the cabin is satisfactory, so that operation using speakers is possible, although basically headphones are preferable for radio contact.

9581

CSO: 3102/411

## TRANSPORTATION

### SIAI MARCHETTI PLANS 'CORMORANO' AMPHIBIAN AIRCRAFT

Rome AVIAZIONE in Italian May 82 pp 282-283

[Article by Marco d'Alessio: "The Cormorano after the Canguro"]

[Text] SIAI Marchetti proposes a new twin-turboprop amphibian. Taking advantage of all the experience acquired with the Canguro, the Agusta-group firm proposes a machine for which a vast market could open up, especially abroad.

The mark that identifies the project is S-700, but in SIAI Marchetti circles they have already given it a more colorful name and one that fully fits the characteristics of this airplane which, once again, is born of an original project by engineer Frati: Cormorano. AVIAZIONE can offer, as a preview, a detailed examination of this new amphibious aircraft which, to judge by its characteristics, could have notable commercial success, also because of the variety of uses for which it is suited.

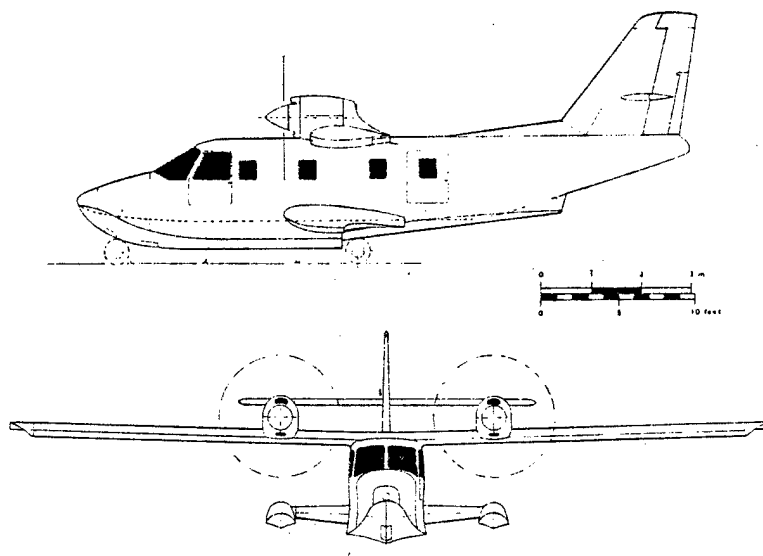
Let us look more closely at this Cormorano, then. As its name suggests to anyone who has at least a little familiarity with the world of birds (the cormorant is a bird that lives on lakes, rivers and the sea), the Cormorano is an amphibious aircraft derived directly from the SF-600 Canguro, the simple utility twin-turboprop that SIAI has already designed and that is undergoing flight tests. The philosophy adopted in the preliminary design phase for construction of the aircraft was to use as much as possible of the structural components and installations of the Canguro. This approach, chosen by the designers for obvious reasons of costs, will also, in our opinion, be beneficial to users of the aircraft who will be able to take advantage of commonality of parts, both in the case of a mixed fleet and in that of a fleet of just a few aircraft that are all amphibians. One consideration to note in this context has to do with the adaptability of Frati's original design, which, thanks to the linearity and simplicity of the solutions adopted, has lent itself to these changes very well.

One of the modifications necessary was the beefing-up of the wing, as necessitated by the increase in all-up weight due to the addition of particular elements that make the aircraft amphibious (float arms, hull). In this area, the SIAI designers have taken good advantage of the latest technological achievements, using new materials and construction technologies for building the hull.

Both the hull and the floats are made of composite materials, and this choice has made it possible not only to achieve an immediate saving but also to offer an aircraft that does not suffer from the problems of corrosion of the immersed part that are typical of use in a marine environment. At the same time, precisely by the use of these construction technologies, a better surface finish and a perfect seal were obtained. From the desire to give the aircraft maximum versatility arose the need to adopt a retractable landing gear, the same one that is offered as an option on the Canguro, which because of its strength enables the aircraft to operate without any problem from grassy fields or semiprepared surfaces, including ones of small size, as we shall see in the takeoff and landing performance characteristics.



The aircraft's aerodynamic elements have been partly revised so as to optimize their characteristics in this new use. In particular, the moving--or better, the flipping--of the engines to the upper side of the wing, to ensure a good distance from water spray, has also made it necessary to raise the horizontal tailplane in order for the surface to remain in the propeller wash from the two engines. The wing, which is high and of square plan, adopts a new profile of high relative thickness-- $GA(W) + 1$ --which, while ensuring a high coefficient of lift, does not increase aerodynamic resistance, does not affect structural lightness and makes it possible to have considerable space available for fuel. The wing does indeed contain four identical tanks with a total capacity of 1,100 liters of fuel, in addition to the 400 liters in the tank fitted into the central hull. The Cormorano takes advantage of the same constant-square-section fuselage that facilitates the loading operations and increases the aircraft's capacity to transport voluminous goods.



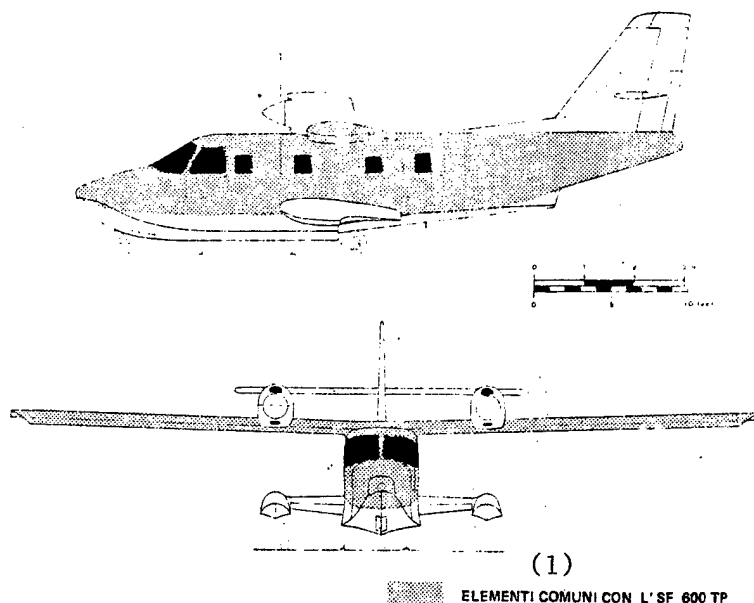
Two views of the S-700 Cormorano in the version with the AR-318's

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The question of the aircraft's motorization is purposely being left open. The Canguro is presently powered by two Lycoming LTP 101's, and this solution could be adopted without problems for the new aircraft too, but the first Cormorano should be powered by the same Allison 250C-17 turboprops that are used by the SM-1019. Within SIAI, though, there are great hopes of being able to build a completely Italian aircraft, and therefore everyone's attention is directed toward the tests that will show how the Alfa Romeo AR-318 goes; an AR-318 is continuing to fly on a King Air in the experimental division. Apart from the nationalistic aspect as such, the Alfa Romeo solution for the Cormorano's engine would also be of considerable nationalistic importance, inasmuch as it could make it possible to overcome all the difficulties of third-country supply and sales that arise with foreign engines. With the two AR-318's that drive two reverse-equipped variable-pitch three-blade propellers, the Cormorano will weigh 2,250 kg empty and will have a maximum takeoff weight of 4,200 kg. Cruising speed at 10,000 feet has been calculated at 180 knots, and with maximum fuel load, the aircraft will have a range of 1,600 km.

We refer the reader to the table for the other technical characteristics, but it seems of interest to go into some detail about the missions for which the aircraft is proposed. In general, it can be said that the Cormorano is a good example of a utility aircraft whose amphibious capacity has increased its possibilities of use especially at sea or in zones in which water surfaces are present and in which the orography of the terrain or the lack of traffic make it inadvisable to build even small airports. In such cases, the Cormorano can

be used as a freight and passenger aircraft connecting isolated or touristic localities with major centers or with international airports. At sea, the Cormorano, with special equipment fitted, can do patrol, search and rescue work, integrating its action with that of rotary-wing craft, over which it has the advantage of lower purchase and operating costs and a more extensive radius of action. Also in the marine environment, another possible use for the aircraft is oil-platform support, even though in this task, proposed by SIAI, it seems to us that the limitations inherent in any fixed-wing aircraft cannot always be overcome even by the amphibious type.



In this drawing, the elements that are common with the SF-600TP are shaded.

Key: 1. Elements common with the SF-600TP

In any case, the characteristic of greatest interest for use of the Cormorano is the possibility of its carrying a module for use as a water-bomber. The module makes it possible to carry 1,300 liters of water and retardants and can be fitted in a few hours. The problem of vast areas subject to more or less "spontaneous" fires during the summer months is not typical of our country only; on the contrary, it is common to many nations. As in Italy, in other countries too the solution that seems most attractive is use of the so-called water-bombers or "fire bombers." The two types of aircraft differ in the liquid ejected (water in the former case, retardant liquids in the latter) and the typology of attack on the flames. While the water bombers work by discharging large quantities of water, preferably soft, directly onto the flames, the fire bomber releases chemical retardants ahead of the fire to keep it from propagating. It is difficult to establish which of the two types is better, especially because the conditions of use vary greatly from place to place, and with them, the output that the two types of craft can deliver. In any case, there is no doubt but that the Cormorano can validly take a place among anti-

# S-700 Cormorano--Technical Characteristics

wingspread	15 m
length	12.15 m
height	3.6 m
wing area	24 m <sup>2</sup>
engines	Alfa Romeo AR-318
power	2 X 580 shp
propellers	three-blade, variable-pitch and reversible
weight empty	2,250 kg
maximum takeoff weight	4,200 kg
12-seat cabin, 1 or 2 pilots	
useful cabin volume	7.9 m <sup>3</sup>
cruising speed at 10,000 feet	180 kts
maximum climbing speed at sea level	1,400 ft/min
takeoff run: - on land	305 m
- on water	450 m
alighting run: - on land	320 m
- on water	300 m
operating ceiling	6,700 m
radius of action	1,600 km

fire aircraft and, thanks to its ability to take on water either conventionally or while floating on water, will be capable of doing considerable work both as a fire bomber and, where water surfaces are available, as a water bomber. According to calculations done by the SIAI technicians, with a water surface within a radius of 10-20 km, the Cormorano can discharge onto a fire, acting as a water bomber, 18.2 or 10.4 tons of water, respectively, every hour.

The amphibious-aircraft sector is very promising from the commercial point of view: the few existing aircraft are now reaching the end of their operational lives, while the market could be particularly interested especially in a simple and robust machine like the Cormorano, which in particular zones of the world such as South America, Africa, Southeast Asia, etc, would find its natural working environment.

11267  
CSO: 3102/382



## TRANSPORTATION

### AIRBUS CONDUCTS FIRST STUDIES OF USE OF 'FFCC' A 300

Paris AVIATION MAGAZINE INTERNATIONAL in French 15-30 Apr 82 pp 49-51

[Article by Serge Brosselin, special correspondent at Djakarta: "A-300 FFCC--  
First Operational Evaluation on Garuda Airline Network"]

[Text] Less than 2 months after having delivered the first FFCC [Forward Facing Crew Cockpit] Airbus to the Garuda Indonesian Airline, officials of the European consortium have conducted an initial operational evaluation of the A-300 in its "all forward-facing" configuration. The evaluation is supplemented by a survey of the factors involved in the introduction of the new procedures.

Between 18 January, the date of receipt of its first A-300 B4, and 12 March, when it took delivery of the sixth of the nine planes it has ordered, the Garuda airline became the first in the world of Airbus Industrie's clients to have received as large a number of planes in as short a span of delivery times: The rate of deliveries actually averages out to one plane every 6 days. To be noted in passing is the fact that the most recently delivered A-300 (No. 159) is indeed the same one that was used for FFCC certification, thus providing an opportunity to draw upon the very first technical and operational data logged with the putting in service of the FFCC. Pierre Baud, assistant to Bernard Ziegler and an Airbus test pilot, first gave a number of details, at Toulouse, from the builder's viewpoint. Then, 4 days later, at Djakarta, Wiweko Supono, president of Garuda, for his part, summed up his first impressions and did not fail, in passing, to add some deeply felt mercurial comments with regard to all those who fail to convey exact and objective information to the public on the FFCC concept. Lastly, three Aeroformation pilot instructors, including Mr Pinet (head of the Toulouse training center), who had participated in the ferrying flight (one technical-inspection stop at Abu Dhabi and a second one at Bangkok), provided insights concerning the entire aspect of distribution of the workload aboard that are all the more priceless in that they are based upon experience gained throughout a period covering both the machine qualification of the Garuda crews and the so-called "line training" phase which immediately precedes the leaving of the pilots entirely on their own.

While he deems that the conclusions to be drawn from 1 month of operation cannot in themselves be considered significant (even though had some serious

mishaps occurred during that same period there are those who would probably have seen no point in questioning the validity of its time span), Pierre Baud nevertheless expressed full satisfaction with the manner in which the Indonesian crews have familiarized themselves with the A-300 FFCC. The only two technical problems that came up during that period were very rapidly resolved. One concerned the modifications it appeared had to be made to the automatic pilot system software; since then, the system has functioned with a very high degree of reliability in all the operational modes associated with its use. The other problem, which has also been resolved, concerned the disconnection of the automatic control lever and the digital automatic pilot, which was occurring at a speed of 100 Kt [knots] during takeoff; Hans Springer, manager of Airbus ground maintenance at Djakarta, told us this had occurred some 10 times. Lastly, to close the chapter on the few problems encountered, one engine had to be changed, an engine that for reasons unknown was not putting out its rated power (thus providing a thrust 7 to 8 percent below normal specifications); and in addition, several operational abnormalities were found in the OMEGA long-distance navigational system, with which the Indonesian airline had chosen to equip itself. It was stressed, however, that the latter did not represent a technological fault inherent in the system with which the Airbus has been equipped but is rather ascribable to external causes related to the operating principle of OMEGA (see AVIATION MAGAZINE INTERNATIONAL No. 811): Radio coverage of this zone of South-east Asia cannot be fully provided until the station currently under construction on Australian territory is put into operation.

#### A Different Distribution of Workload

The rate of usage of the Airbuses on the Garuda network currently averages 7 hours 45 minutes of flight per plane per day, each plane completing an average of 28 round trips per week. But beyond the different findings with respect to the availability factor of the planes, it is very evidently all the observations reported with respect to the behavioral response of the crews to the FFCC and the manner in which they have adapted to it that have been, as they should be, the main center of attention. In this regard, the president of Garuda has expressed his satisfaction at the ease and speed with which the airline's pilots have familiarized themselves with the Airbus dual-pilot system. He said in substance: "The fact that a plane is dual-piloted does not necessarily imply any added risk of accident; those who continue to advocate three-man crews are ridiculous." The company's pilots, he added, have already acquired some experience with dual pilotage and have found that with the Airbus FFCC the workload appears to be even less than that on the DC-9's currently operating on the Garuda network (the Airbus, for example, has the automatic control lever).

Asked also about the possible modifications that Garuda may eventually want to make to its fleet of Airbuses, Wiweko Supono said that for purely financial reasons he does not envision, at least for the time being, retrofitting the planes with color cathode tubes. Similarly, the head of Garuda made it clear that he is not considering at this time equipping the planes with Class III automatic landing gear.

All the different questions having to do with the implementation of the new procedures and with the changes in the distribution of the on-board workload brought about by the introduction of the FFCC were addressed by the team of Aeroformation personnel that has converted the Indonesian pilots to FFCC. The various instructor pilots were given the opportunity to meet all confirmed the very high degree of competence shown by the Garuda pilots. "From the very start," one of them said to us, "we became aware that we were dealing with pilots gifted with very agile minds, so much so that there was a tendency to more or less unconsciously take over some of the work incumbent upon the other cockpit crew member to perform at the time. To be exact, this "excess efficiency" finally compelled us to suspend one phase in their progression so as to again "brief" the pilots on just what functions each one of them was expected to take on to himself." The fact is, according to Mr. Pinet, the training of young pilots to pilot an FFCC plane presents absolutely no major difficulty, since the basic requirement involved is much more in the nature of openness of mind than one of experience acquired over a long period of having piloted a three-man crewed plane.

The progressive stages set up for the training of the Garuda pilots by Aeroformation were as follows: 20 hours of "procedure" simulator, 28 hours of pilotage simulator to which are added 6 hours of actual flight, or a total of 54 hours of training for a crew of two pilots. In an FFCC cockpit--in view of the absence of a third crew member--it is agreed that the pilot who is not at the controls takes action to correct any malfunction. During the qualifying period at Toulouse, the two pilots were graded simultaneously; one of the instructors even said that a decision had been taken to be more severe in the grading of the pilot among the two crew members who was not piloting at the time.

Assuming a malfunction occurs, the procedures to be applied on the FFCC A-300 are grouped under two categories of intervention: The emergency checklist and the non-urgent checklist. In the first of these two categories (20 possible malfunctions are included), the number of actions to be performed for each sequence has been limited on average to three interventions. For these 20 cases of malfunction, the crew must imperatively apply a memorized checklist. For the so-called "non-urgent" procedures, on the other hand, the pilots are not required to memorize the checklist; the different actions to be taken one after the other to isolate the trouble are listed on cards showing four possible "arrangements": The number 1 placed alongside a specific action indicates that the said action is to be taken by the pilot at the controls; the number 2 indicates an action that is the responsibility of the other pilot who is at the moment not piloting the plane; groups CM1 and CM2 identify respectively the crew member seated on the left and the one seated on the right.

Another question that of course was very much addressed throughout our talks was: What influence does the FFCC cockpit have on the behavior of the crews, or, in other words, to what extent does it contribute to the conditioning of new reflexes? The response to this question centers on two aspects. First of all, as regards the workload aspect, the greater availability of the crew is put to advantage in exercising a more "analytical" surveillance of the functioning of

the systems. The overhead position of one of the instrument panels compels the crew to raise their eyes and to think out problems that have heretofore been solely the prerogative of the flight engineer and navigator. Secondly, it is pointed out, piloting of the FFCC has brought about a new awareness on the part of the crews; They have discovered that they are as capable as was the third man of the dealing with piloting parameters they were heretofore not permitted to address directly. We cite, by way of example, control of the different parameters involved in the starting up of the engines, the regulation of cabin temperatures, etc...

Lastly, it seemed very difficult to avoid addressing the fundamental question--dual pilotage or 3-man pilotage?--in terms of the operational safety of the FFCC. In this new version of the "battle of Hernani," it seems that the controversy that is pitting the older view against the more modern one is tilting little by little in favor of the latter. Extreme caution undeniably still warrants a detached view of events thus far, but on the other hand one cannot avoid adding two facts to the dossier. First of all, some pilots do not hesitate to state that--provided, of course, the reliability of the FFCC becomes established--it is much easier to divide the workload between two than among three. In the second place, the tests that have been carried out, on the simulator as well as on line, have shown that the simulated failure of one member of the crew has no effect whatever on the safety of the flight: The member who remains at the controls is fully capable of absorbing the additional workload resulting from the unavailability of his colleague.

Airbus Industrie and the different equipment manufacturers involved in the A-300 B4-FFCC program (SFENA [French Air-Navigation Equipment Company], Sperry, Smith Industrie, Jaeger, EAS [Europe Air Services], Intertechnique, Pratt and Whitney, SOGERMA [expansion unknown], etc) are assisting Garuda in everything concerning the maintenance of the planes currently operating in Indonesia. This presence, it was pointed out, is aimed at providing technical assistance and serving as consultants to the Indonesian technicians.

By early 1983, Garuda will have taken delivery of the A-300 FFCC flight simulator, which is to be installed at the Indonesian airline's PNT [expansion unknown] training center at Djakarta.

#### A-310: Flight Test Schedule

Some details concerning the A-310 flight test schedule were also provided by Pierre Baud at Toulouse on 11 March. According to Bernard Ziegler's assistant, the technical aspects of the plane are expected to be frozen by September.

The first three prototypes, two of which are to be equipped with Pratt and Whitney jets and the third with GE engines, will serve for the basic certification (coverage of the VOM [expansion unknown] domain).

Two other A-310's will undergo "temperature" test runs and "route proving" test runs. The five planes will make their maiden flights in April, May, August, December of this year, and February 1983, respectively.

Approximately 1 week is being devoted to ground tests. Extension of the flight domain is scheduled for this June.

To date, 13 airline companies have already ordered the A-310, the most recent one--Cyprus Airways--having decided to purchase two of these planes.

9399

CSO: 3102/378

## TRANSPORTATION

### COMMENTS ON LAUNCH STRATEGY FOR AIRBUS A 320

Paris AVIATION MAGAZINE INTERNATIONAL in French 15-30 Apr 82 p 14

[Article by Gordon Swanborough: "When Should A 320 Be Launched?"]

[Text] An observant visitor to Airbus Industrie in Toulouse today has no trouble noting that the intent of the European consortium is not solely to mark up a big score in the development of its A-300 and A-310 programs but also to proceed rapidly to the launching of a third member of the Airbus family: the A-320.

There can be no question that this plane will fill the needs of a goodly number of airline companies toward the end of the 1980's insofar as concerns the market for 150-passenger airliners. A market, let us recall, that has been estimated at 6,000 planes between now and the year 2000, one-third of which Airbus Industrie expects to capture.

Across the Channel, however, there are uncertainties as to whether the A-320 can be launched this year. Uncertainties not indicative of any reservations as to the design of the plane. Actually, uncertainties stemming in general from the current slump in the air transportation industry.

British Aerospace, which--as we have already pointed out--wants a substantial share in the new program, as a partner in Airbus Industrie, calls attention to the risk involved in taking too early a decision to launch production of the plane. The fact is that the enthusiasm on the part of one or two airline companies for the A-320 (Air France and Delta) must be weighed against the financial difficulties besetting many others.

And in all objectivity, there can be no doubt that the difficulties confronting numerous airlines must be perceived as dampers on the growth of air traffic. Difficulties that are entirely real for the shareholders who are receiving no dividends, for the employees who are losing their jobs, and for the financial institutions that are having to carry the bag (the air transportation industry's results having been so bad in 1980-1981--and they will probably be so again in 1982--it is certain to be some time before the confidence of the financiers and bankers will again be restored).

In short, the A-320 clearly could not be launched without a significant number of orders in hand. In Great Britain, however, the thinking is that even if a sufficient number of orders were to materialize in the near future (there is a real possibility that Delta may decide in favor of the 150-passenger plane within the next 6 months), a premature launching of the plane could be followed by a serious lack of orders, similar to the one experienced by Boeing with its 757.

The fact is that to be a significant economic success, the new plane will have to be produced at a sufficient rate to avoid negative repercussions on Airbus Industrie's financial resources and, hence, probably on the unit cost per plane. In other words: Looking down the pike and beyond a substantial number of immediate orders, there must be reasonable assurance that future clients will not be experiencing disastrous financial straits.

There are factors, of course, that must be taken into account by the Airbus Industrie partners. True, all things considered, the fact that the American builders have also not yet decided to launch a 150-passenger plane could mean that they feel they are unable to compete with the European consortium from the standpoint of timetables. On the other hand, however, if the Europeans wait until market conditions are ideal to launch their new plane, obviously this will give Boeing and McDonnell-Douglas more time to complete the study of their new planes and to become thus more competitive.

The path the Europeans must trod is therefore a very narrow one. Without forgetting, of course, the question of the engines. But that is another problem...

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CSO: 3102/378

## TRANSPORTATION

### ENGINE MANUFACTURERS VIE FOR OPPORTUNITY TO EQUIP A 320

Paris AVIATION MAGAZINE INTERNATIONAL in French 15 Aug 82 p 11

[Article by Roger Cabiatic]

[Text] The evolution of the situation in which the airbus A-320 project finds itself will be, without any doubt, one of the principal themes of conversations both official and unofficial that will take place during the Farnborough air show. The recent acceptance in principle by Canada to participate in the construction of this new, twin-engined, short medium-range, 150-seat transport, the prospect of a reduction in shares for the airbus industrie partner firms in civil aircraft research and development, a certain clarification of the problem posed by the choice of the engine to be a part of the project, surely will be reasons that will bring up the launching of the program, while taking into consideration the tenacious stagnation, even recession, in the civil aircraft market.

In order to proceed with technical plans, one of the major problems posed for the airframe designer is that of choosing the best possible engine which is the most important item relating to optimal commercial operation of the aircraft. It is necessary to charge the engine manufacturers with building a new engine if it does not already exist in their catalogues.

For the engine manufacturers concerned, anxious to reach the point of profitability for their present projects or those already under development as quickly as possible, it suggests they be prudent: torn between their desire to be the first in a new market segment and the fear of being victims of a "premature leap forward" that can prove fatal to their business, they react in different ways.

In 1981, Pratt & Whitney accounted for 68 percent of the turnover of the United Technologies Group of which it is an affiliate. It also recorded, relative to the previous year, a drop in sales of 30 percent in the civil aircraft engine sector: but the determination exhibited by its directors of maintaining itself as the number one designer in the world, a determination accompanied by the significant financial reserves available to the group, drives this engine manufacturer to try to put together the conditions necessary for the launching of a new engine.



In developing in association with the Japanese industrialists the RJ-500 demonstration engine, Rolls-Royce has gotten a lead on its competitors; but the partners involved in this project do not appear to be in a position to go further with the program without the cooperation of an American engine builder that would be prepared to share the risks and open the market.

Therefore, it is logical that Pratt & Whitney with its German (MTU) and Italian (Fiat) Associates, and Rolls-Royce with its Japanese partners (Ishikawajima, Kawasaki and Mitsubishi) would try to pool their resources to try to develop together the engine the Airframe manufacturers dream about. This is a difficult business if one considers that it will mean putting together a collaborative arrangement with seven partners not to mention two different engine designs: Rolls-Royce (three spools) and Pratt & Whitney (two spools).

For their part, General Electric and SNECMA, who jointly produce the CFM-56, do not envisage, at least for now, attempting a new engine. For economic reasons, the two firms do not see a need for launching a new engine before having exhausted the development potential of the CFM-56; even while pursuing its civilian jet engine programs, General Electric, it seems, is inclined to orient its efforts toward the military market that is judged to be more stable due to the defense policy established by President Reagan and the choices that result from that.

For a long time, the CFM-56 solution was rejected by Airbus Industrie since the performance of that engine was held to be lacking in the area of specific fuel consumption; today the adoption of the French/American engine is still uncertain; but, three important factors have improved its chances. For one thing, Delta Airlines which could be the launching customer for the A-320 in the United States and whose demands caused Airbus Industrie to insist on a new engine has put off its decision on the aircraft to a later date. In addition, the most highly developed version of the CFM-56, the CFM-56-2K2, recently offered to the Airframe manufacturer, will provide almost all the performance expected by the air lines. To these two favorable elements should be added the verdict of the calendar. Accepting the hypothesis that they will be able to reach an agreement, Pratt & Whitney and Rolls-Royce will probably not be able to put into commercial service the new engine that would result from their cooperation before 1988; on the other hand, the CFM-56-2K2 would be available from the beginning of 1987, some 12 months earlier; that is an advantage that the European Airframe manufacturer now appears ready to exploit with the airlines interested in the aircraft. Let us hope that Airbus Industrie will succeed quickly in its efforts.

CSO: 3102/432

## TRANSPORTATION

### RESEARCHERS SAY NO CERAMIC ENGINE IN NEAR FUTURE

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 22 Jul 82  
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Text] In the years ahead one can expect initially simple ceramic components will help to make combustion engines more efficient, lighter, quieter and, through improved combustion, less polluting. This is the opinion of Prof Guenther Petzow from Stuttgart, head of the laboratory for Powdered Metallurgy at the Max Planck Institute for Metals Research. So far, he said, "manufacturing and material-related problems of considerable magnitude" have stood in the way of the use of ceramic materials to replace metals in the manufacture of automobile engines. Mass production creates problems mainly because existing production processes are unable to achieve consistent quality in the ceramic materials, which are considerably more heat-resistant compared to metals. Prof Petzow went on to explain that an engine consisting entirely of ceramic materials continued to be a "long-term project," whose realization was by no means Utopian, but which was attended by considerable difficulties.

The widely heralded "revolution in engine construction through the miracle material ceramics" was not quite ready to take place, stressed Prof Petzow. Experimental engines which had been shown recently were only demonstration pieces, which mainly demonstrated the enormous material potential of ceramic engines, which has scarcely been tapped so far. They proved that the ceramic engine works in principle. Even if mass production of the ceramic engine was not yet in sight, almost every manufacturer of engines and turbines in the world, as well as companies in the ceramics industry, often subsidized by substantial state support, was working feverishly on the development of ceramic materials for engines.

Ceramics, the oldest material of man, (from the Greek: ceramos--burned earth) has an excellent potential of becoming the most modern material in engine construction. In the eyes of the scientist, modern ceramics has very little in common with the classical materials that have been in use for more than 10,000 years in the potter's art. "These are a totally new class of tailor-made materials, which can be subjected to temperatures of more than 1,200° C, a heat at which traditional metals without cooling have long since collapsed," said Petzow.

The advance into a range of temperatures, which has so far proved very difficult for technology to penetrate, holds great expectations. Because ceramics provide better heat insulation, the efficiency of combustion engines can be markedly increased, for heat engines utilize energy better as the working temperature increases. Fuel is

burned more efficiently, fewer exhaust emissions are created and the environment is polluted less. Also, Petzow believes, because of the superior insulation of the combustion chamber achieved by the use of ceramics, the cooling system, including the fan, hoses and V-belt, could be dispensed with. This creates hotter exhaust gases, which means, for example, that exhaust-driven turbochargers could be utilized more effectively. They could push even more preheated air into the combustion chambers and thus increase engine output or reduce specific fuel consumption. In the future engineers want to utilize these advantages in the plans for a diesel engine working without a heat exchanger.

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CSO: 3102/416

## TRANSPORTATION

### BRIEFS

EXPERIMENTAL TRAIN SETS RECORD--The experimental railroad vehicle VF 1 from Krupp Industrie und Stahlbau, Essen, has attained a simulated speed of over 500 kms/hour in tests on the roller dynamometer in Munich-Freimann. According to Krupp this established a new world record. The roller dynamometer is a track simulator on which the running characteristics of rail vehicles can be studied scientifically, while they remain stationary when running. The experimental vehicle, developed and built by Krupp, which is heading the project, is being used to study the interaction of vehicle and track. In experimental runs between Guetersloh and Neubeckum it has already reached 250 kms/hour, the highest speed currently permitted in the FRG. Higher speeds up to about 350 kms/hour will be possible, Krupp reports, at the planned experimental rail facility, which is to be built from an expanded low-traffic secondary line near Rheine. According to the company, German wheel-on-rail research has no plans to establish rail world speed records, but will continue development of wheel-on-rail technology, finding an optimum balance between what is technically possible and what is economically feasible, at the same time preserving and further expanding the advantages of the railroad as the safest and environmentally most benign form of transportation, even at higher speeds. The results of research obtained so far and those expected should prove that continued wheel-on-rail technology will be technically and economically able to prevail in the face of all old and new transportation technologies over the distances normal for central Europe.

[Text] [Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 22 Jul p 7] 9581

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